PATENT SPECIFICATION

DRAWINGS ATTACHED

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836,555

Date of filing Complete Specification Oct. 26, 1956.

Application Date Nov. 9, 1955. *No. 32007/55.*

Complete Specification Published June 1, 1960.

Index at acceptance:—Classes **2(5)**, R(3A:21A:22A); **2(6)**, P4(A:D3B1:K10), P7(A:D1A), P10A, P10D(1A:2A), P10K(4:10); **70**, E(8A:11:16); **74(1)**, J; **87(2)**, A1G(3X:4X:7C:10:12), A2(A1:A3:B1:B2); and **140**, A2(N1:N2:N3:N4:N5:P), A10B3, A12.

International Classification:—**B29d. C08c, f, g. D04g.**

COMPLETE SPECIFICATION

Improvements relating to the Production of Net or Netlike Fabrics by Extrusion Methods

We, PLASTIC TEXTILE ACCESSORIES LIMITED, a British Company, formerly of 8, St. Peter Street, Blackburn, now of 25, Richmond Terrace, Blackburn, Lancashire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the manufacture of net or net-like fabric (hereinafter, in general, referred to as "fabric") in a plastic as hereinafter defined, and has for its object the production of a plastic fabric by a method and apparatus according to which the product is manufactured in a single operation as a unitary net structure in contradistinction to hitherto proposed methods involving the extrusion of a series of monofilaments and their subsequent fabrication into a net-like product by laying the filaments on a rotating drum or travelling band conveyor in contiguous or crossing relation with one another so that they may become welded or stuck together at the crossing points or overlapping of the filaments.

The invention consists in a plastic net or net-like fabric having mesh strands and intersections, characterised in that the intersections are each composed of an integrally extruded mass and the mesh strands are divisions from the said intersections, the whole net being an integral extruded entity.

The invention also consists in a method of manufacture of a net or net-like product by extruding the plastic through two sets of die orifices which sets are relatively displaced transversely to the direction of extrusion into positions in which die discharge orifices of one set are in registration with those of the other set to provide a series of individual orifices each composed of an orifice of the respective sets during which registration extrusion of the net intersections takes place through said composite die orifices and into positions of non-registration of the die orifices of the sets through each of the orifices of which independent extrusion takes place of the mesh-forming strands which are divided from the intersections with a shearing action as the dies move from the registration to the non-registration position.

The invention further consists in apparatus for carrying out the above method comprising means for feeding plastic under pressure to a pair of die-carrying members having contacting slideways, dies extending through the members with the die discharge orifices at the slideway surfaces, and means for displacing the die-carrying members in the said transverse direction for placing the die discharge orifices of each member into positions of registration and non-registration with one another.

The sets of dies may be arranged in an annulus or they may be rectilinear and the said relative displacement may be rotary, partial rotary or oscillatory in reference to the annular sets of dies, or where the sets of dies are rectilinear the displacement is reciprocatory.

As the net structure or fabric emerges from the extrusion dies it is set or fixed by subsequent treatment according to the nature and requirements of the particular plastic employed and the fixed plastic is taken up by suitable haul-off or supporting and gathering-in means.

The term "sets" in reference to the dies

has been employed herein and in the claims, as usually each die-carrying member will have a considerable number of dies but the word "set" is also intended to include a minimum of a single die on one die-carrying member displaceable relatively to and co-operating with a number of dies on the other die-carrying member according to the number of strands predetermined for the fabric.

The term "register" or "registration" as used herein and in the claims means such juxtapositioning of the die orifices of the respective sets in their displacement as to coincide or come exactly opposite to one another or into partially overlapping positions, so that each registering pair of die orifices forms a single composite orifice common to both sets of dies, through which each integral intersection is extruded.

By the term "plastic" (as used herein and in the claims) is meant:—

(a) a synthetic thermoplastic capable of melt or compression extrusion in a molten state through dies and settable by a cooling medium on issuance from the dies. Suitable or superpolyamides, such as nylon; polyesters; thermoplastic materials include polyamides polyvinylchloride and copolymers thereof with vinylacetate or vinylidine chloride; polythene and the like and cellulose acetate; or

(b) natural or synthetic rubbers, subsequently vulcanised or containing vulcanising agents; or

(c) those thermosetting plastic materials or mixtures thereof with thermoplastic materials, which are capable of extrusion; or

(d) wet spinnable materials, such as viscose, cuprammonium cellulose, or protein material (e.g. from soya bean), capable of extrusion and setting by immersion in or spraying with a coagulant as the plastic emerges from the dies.

Further features of the invention will hereinafter appear.

In the accompanying drawings:—

Figure 1 is a sectional elevation of one form of extrusion apparatus according to the invention in which coaxial annular die-carrying members are employed;

Figure 2is an inverted plan of the apparatus according to Figure 1;

Figure 3 is a fragmentary perspective sectional view of the apparatus seen in Figure 1;

Figure 4 is an enlarged perspective view of a part of the inner die-carrying member seen in Figure 3 illustrating the open-sided slot form of extrusion die vertically disposed although such may be located at an angle to the vertical and inclined in the same sense or opposite to that of die displacement;

Figure 5 is a general elevation of a circular extrusion machine in which the apparatus of Figures 1 to 3 is shown in section located over a coolant tank and associated with haul off mechanism for tubular extruded fabric and means for slitting the tube;

Figure 6 is a fragmentary sectional elevation of extrusion apparatus of the form employing rectilinear die-carrying members;

Figure 7 is an inverted plan of a fragment of the apparatus according to Figure 6;

Figure 8 is a perspective enlargement in sectional elevation of Figure 6;

Figures 9 to 11 are sectional plans showing several of the shapes of die employable in the extrusion apparatus;

Figure 12 is a sectional elevation showing fragments of the die-carrying members illustrating a modified form or arrangement of dies;

Figures 13 to 18 are perspective diagrams illustrating the principles of extrusion according to the invention in several successive stages;

Figure 19 is a perspective diagram illustrating the type of extrusion obtained in using a stationary die carrying member in conjunction with a reciprocatory or oscillatory die carrying member having a stroke equal to the pitch of interval between the dies; and

Figures 20 to 25 are diagrams of several of the various fabric patterns produceable according to the invention.

In carrying out the invention according to a melt extrusion mode, described by way of example (see Figures 1, 2, 3, 4 and 5) in which annular co-axial sets of extrusion dies are employed, and between which continuous rotary or oscillatory displacement takes place transversely to the direction of extrusion, the thermoplastic for extrusion is contained in a head or pressure tank or reservoir or hopper *a* which is heat jacketed or heated in any convenient manner according to known practice. From the tank extends a suitably supported conduit 1, in which a pressure worm 2 is mounted and continuously rotated in known manner to maintain a forced feed from the said tank. The end of the conduit 1 discharges into a feed chamber 3 through a gauze screen and breaker plate indicated at 3*a*. The chamber 3 has an electrically heated jacket 3*b* or other heating means in order to maintain the plastic delivered by the worm 2 at an appropriate extrusion temperature. The upper end of the chamber has a gland and bearing 3*c* for a vertical rotatable shaft 4 and the lower end is coupled to an extrusion chamber 5 secured by a screwthreaded neck or otherwise, the arrangement being such that the two chambers 3 and 5 are fixedly supported with conduit 1 in a frame or base in any convenient manner on an extrusion machine *b* of known type as seen on the left of Figure 5.

The cavity of the chamber 5 has a frustoconical wall 5*a* which supports an outer annular die-carrying member 6 in such a manner that the member is capable (in the

present instance) of rotation about the axis of the shaft 4. For example, the lower end of the chamber 5 may be rebated to receive an upwardly directed annular flange provided on the die member 6, the externally peripheral wall of which is formed with a bearing groove 6a. A split cylinder or sleeve 7 is releasably clamped around the chamber 5 and embracing the die member 6, thereby permitting the removal of the die member 6 and replacement by another having a different set of dies.

The cylinder 7 is electrically or otherwise heated by a jacket 8 and has an annular rib or rail 7a located in the groove 6a. The rib and groove serve as a guiding and supporting bearing for the rotating die member 6.

The lower end of the inner peripheral wall 6b of the member 6 terminates in a circular bevelled or frusto-conical slideway 9 in which a set of spaced die ducts 10 of suitable cross-sectional shape are formed. The die member 6 may be rotated by any suitable means, for instance it may have secured to its underside a chain wheel 11, the chain 11a of which is passed round another chain wheel 11b which is driven through gearing from a variable speed electric motor 11c or other suitable source of power.

The shaft 4 has attached to it a replaceable inner or core-like die-carrying member 12 which cooperates with the outer die member 6. This inner die member is bevelled, preferably at a slightly less steep angle than the frusto-conical wall 5a, such that the two conical wallings enclose an annular distributing passageway or cavity 12a for the plastic.

The lower end of the member 12 terminates in a circular slideway 13 which is coned exactly to accord with the coning of the slideway 9 of the die-carrying member 6 and the two slideways are carefully ground to a precise fit to provide relatively rotatable contacting surfaces.

The slideway 13 has a set of spaced die ducts 14 situated opposite to the set 10 of the slideway 9. The die ducts 10 and 14 in the present example are in the form of grooves or slots which are laterally open to one another as they come into register during relative rotation (as described hereinafter) of the die-carrying members 6 and 12 such that extrusion takes place in common confluently through each registering pair of dies of the two sets, while correspondingly during continued rotation the dies of each set are periodically cut off from one another and constitute separate and independent extrusion dies as the die slots of one slideway traverse the plain surface or lands between the dies of the other slideway.

The shaft 4 is hung on a ball or roller thrust race 15 above the gland 3c of the feed chamber 3 and the upper extremity of the shaft is steadied in a bearing 16 and a second thrust race is provided at 17.

Between the two races a chain wheel 18 is pinned to the shaft 4 as a convenient means for imparting rotation to the shaft. A chain 18a may be driven from the same or a different source as the chain 11a such as a variable speed electric motor 18b.

On each side of this chain wheel 18 the shaft 4 is screwthreaded for pairs of die-setting adjustable and lock nuts 19 and 20. By the relative adjustment of these nuts, the appropriate sliding engagement is maintained between the contacting surfaces of the slideways 9 and 13. As these surfaces are coned the mating thereof is substantially perfect and can be so maintained during wear by axial adjustment of the shaft 4.

In operation, assuming the die-carrying members 6 and 12 are both continuously rotated by their chain wheels in opposite directions as shown by the arrows, (Fig. 2) at the same rate, a fabric will be extruded from the dies in which the strands are laid in a pair of crossing opposite helices. The plastic, in a suitably molten state, is forced by the worm 2 from the conduit 1, through the feed chamber 3 and through the annular passageway 12a. As the plastic arrives at the orifices of both sets of dies it is forced therethrough and is continuously extruded. When and while the dies 10 and 14 of the respective sets are in register with one another, a net intersection forming stream of plastic issues from each registered pair of die orifices, which together form a composite extrusion orifice. As rotation of the die members proceeds these intersection streams will each be divided diametrically or chordwise with a shearing action on the plastic within the dies 10 and 14 as they separate laterally in passing out of register and begin to traverse the blank contacting portions or lands of the surfaces of the slideways 9 and 13 which intervene between the dies of each set. In the out-of-register positions the dies of each set continue to extrude the plastic independent of the other set to produce the strands or legs of the meshes uniting the intersections.

As the extrusion is continuous throughout the process the rotating dies will alternately produce intersections and mesh strands and thus extrude a continuous integral fabric of tubular form. The meshes will be of diamond-like shape and their size will depend upon the length of the spacing or pitch interval between the dies of the sets and the helical angle or obliquity of the strands will depend upon the speed of rotation—the faster the speed, the shallower will be the angle or pitch of the helices of the strands, while correspondingly the slower the speed of rotation, the steeper will the helical angle of the strands become.

Assuming that the sets have dies of the same cross-sectional area and are rotated at the same rate, the same amount of plastic

will be extruded through each set at the registration periods for the intersections and half that amount will be extruded from each die of the respective sets during non-registration periods and mesh strands of uniform but diminished thickness or gauge will be extruded.

The finished form of the fabric as extruded will be tubular but the tubular form may be slit longitudinally to provide a flat fabric as is known in the tubular production of flat fabrics or sheet material in general from tubular forms.

While in the above description it has been assumed that the sets of dies are to be rotated in opposite directions, the apparatus is susceptible of a variety of modifications in the nature of the relative displacement of the sets of dies and this aspect of the invention will be dealt with and explained hereinafter, as also will the effect of variations of size and spacing of the dies and the effects producible by tensioning or racking of the meshes of the extruded fabric.

The fabric as extruded will normally be subjected to a setting or fixing treatment, as by spraying it with a coolant or immersing it in a cooling liquid in a tank immediately below the extrusion dies as will be described hereinafter.

In carrying out the invention by the use of rectilinear sets of extrusion dies, which are reciprocated transversely to the direction of extrusion, as exemplified in Figures 6—8 (wherein like references are applied to corresponding parts as have been used in respect of Figures 1—4), the feed conduit 1 and forcing worm 2 deliver molten plastic through the gauze and breaker plate 3*a* to the feed chamber 3 kept at the appropriate temperature. This chamber has attached to it by screw-threaded or other means, an extrusion chamber 5 (with heaters 8), the cavity of both chambers being elongated or fanned out in both directions from the inlet part 3*d* at right-angles to the plane of the paper in Fig. 6 and seen in the inverted plan of Fig. 7 in dotted lines, to form a narrowing rectangular part 5*b*, the extent of which is commensurate with the range of the sets of dies allowing for the reciprocating stroke thereof such that all dies are open to the plastic within the extrusion chamber 5.

This chamber at its lower part 7 has tongues or rails 7*a* on which the die-carrying members 6 and 12 are guided and slide in their reciprocating displacement. The two oppositely positioned die-carrying members 6 and 12 have rearward rectilinear recesses 6*a*, 12*a* which accommodate the rails 7*a* leaving a forked rail form 6*b*, 12*b*, which lies in recesses above and below the rails 7*a*. The forked rails 6*b*, 12*b*, are reciprocated against thrust balls 7*b* of which the pressure may be adjusted by set screws 7*c*.

The die-carrying members 6 and 12 have bevelled entry surfaces 6*c* and 12*c* which terminate at the vertical dividing plane between the contacting slideway surfaces 9 and 13, in each of which is formed a set of dies in the form of laterally open slots or grooves 10 and 14. Each member has a blank smooth surface at each end portion containing no dies, the length of these blanks being somewhat greater than the maximum reciprocating stroke of the die displacement. Sealing gaskets or sealing grooving may be provided to prevent the escape of plastic between the surface of the die-carrying members and the parts of the plastic supply chamber against which the members have sliding contact.

Any suitable means, such as interchangeable eccentrics or cams or crank and link mechanisms may be provided and driven from any appropriate power source for reciprocating the die members 6 and 12 through a predetermined stroke in mutually opposite directions, as indicated by the arrows, Fig. 7.

As in the case of the annular rotary die arrangement (Figs. 1—4) so in the rectilinear, reciprocatory or oscillatory die arrangement modifications may be made, and there will be indicated hereinafter variations as to relative displacement, reciprocating stroke, spacing and size of the dies etc. of which the apparatus is susceptible, together with the effects producible by subsequent treatment by tension, racking or forming under heat and pressure of the extruded fabric.

The annular and the rectilinear extrusion apparatus above described is each mounted, over, or its lower surface immersed in, a bath of cooling liquid, which may be water or other liquid appropriate for setting the particular plastic under treatment as soon as the fabric is extruded from the dies. Alternately, the cooling or fixing of the extruded fabric may be effected, by spraying it with cooling liquid or subjecting it to refrigerated air or gas currents.

Within the cooling bath or associated therewith or adjacent the spraying or refrigerating zone, haul off rolls or equivalent means are provided to take up and support the fabric in a manner similar to that adopted in the production of fabrics or sheet material of known kind.

Appropriate setting or fixing means and haul off apparatus are exemplified in Fig. 5 with respect to the annular extrusion method. The extruded tubular fabric as it emerges from the dies is drawn over a vertical cylindrical support or former 31 calculated to maintain the diameter of the tubular fabric while setting and to ensure an even haul off.

The support 21 may be surrounded with a suitably supported tension ring 21*a* between which and the former 21 the fabric passes and on which the tension ring bears with appropriate friction. The former 21 may be sup-

ported in any convenient manner, for example where the tubular fabric is to be slit for producing a flat fabric the former 21 may be mounted on a bracket fixed on the side of a cooling tank referred to below. Where, however, the final product is to be tubular, the former 21 is either omitted or suspended from an anti-friction bearing from the inner die member 12 or on the shaft 4. Alternatively, the shaft 4 may be hollow and have a coaxial rod supported at the upper end above the bearing 16 and carrying the former 21 at its lower end.

Assuming that a finally flat fabric is required, a cutting or slitting wheel 22 is mounted below the former 21.

The fabric is drawn downwards through a pair of rollers 23 which are driven through variable speed means from a suitable source (not shown) and from the rollers 23 the fabric is carried away as over a roller 24, to a suitable batching or collecting source.

If the setting or fixation of the extruded plastic is to be by immersion in a liquid the above-described haul off mechanism is located in a coolant tank 25, the level of the liquid in which is indicated at 25*a*.

For fixing fabric and hauling off initially flat fabric as extruded from the rectilinear die apparatus described, similar apparatus as is employed for the tubular fabric may be employed with the omission of the cylinder 21 and tension ring 21*a*. If desired, the haul off by rollers 23 may be controlled by passing the fabric as extruded between a pair of slightly spaced plates.

It will be observed that for any given extrusion rate and relative displacement speed of the dies, the cross-sectional area of the mesh strands may be diminished and the size of the meshes of the fabric as extruded may be increased by appropriately increasing the haul off rate by the rollers 23.

In the apparatus having annular sets of dies, the relative transverse displacement may take place in the several ways set out hereunder:—

(a) The die-carrying members may continuously rotate in opposite directions at the same rate (as above described in reference to Figs. 1—4).

(b) The members may be rotated continuously in opposite directions at different rates.

(c) The members may be rotated continuously in the same direction but at differential rates such that one set of dies is progressively overtaking the other set to bring about the registration and non-registration positions.

(d) The displacement according to (a) (b) (c) above may be employed but the movement may be stepwise, as effected by ratchet or like gear instead of by continuous rotation, in which case the arrangement may be such that a pause takes place at the die registration positions when the intersections of the mesh will be elongated or it may take place at the non-registration positions when the mesh strands will be elongated. A somewhat similar effect can be attained by varying the speed at which the dies pass one another or move through the positions of non-registration.

(e) The die members may both be oscillated to and fro in opposite sense through a minimum stroke of half the pitch of the spacing interval of the dies.

(f) Of the two die members, one may be stationary and the other may be (1) rotated continuously, when the stationary dies will produce longitudinal strands and the moving dies will extrude helical or oblique strands or (2) may be oscillated back and forth, when the moving set of dies will afford extruded strands zig-zagging to and from the longitudinal strands issuing from the stationary set of dies. In this kind of displacement the moving set of dies is given a minimum stroke equal to the pitch of the die spacing.

In the case of apparatus embodying the rectilinear sets of dies, the several kinds of oscillatory displacement set out under (e) and (f) (2) above may be employed (in the form of rectilinear reciprocation).

With apparatus having annular or rectilinear die members the oscillations or reciprocations may be varied as to the stroke of the displacements according to predetermined requirements, such that each die of one set comes into registration alternately with the two adjacent dies of the other set, or each die of one or both sets traverses and registers with several dies of the other set.

Where the dies do not move at the same rate and where one set is stationary, that moving at the faster rate or the moving die will extrude longer filaments or strands than those extruded by the slower moving or stationary dies, and consequently a greater quantity of plastic will be required, and this is supplied by making these dies of greater cross-sectional area than the stationary or slower moving set.

By the several kinds of displacement indicated above, it will be appreciated that the patterns of the extruded fabrics may be varied considerably.

The dies of the respective sets may be duplicates of one another or the shape in cross-section and area of one set may differ from those of the other set. In Figs. 9, 10 and 11 fragments of die-carrying members 6 and 12 are illustrated for convenience in the rectilinear form. In these figures several suitable shapes of die ducts 10 and 14 are shown in sectional plan.

In Fig. 12 is illustrated a form of converging die ducts 10 and 14 in members 6 and 12 where the lower ends of each of the die ducts are bevelled to intersect and together

each pair of bevelled openings forms a common or composite extrusion orifice when they are in register. The area of the orifices may be increased by grinding back the under surface of the die-carrying members 6 and 12. The spacing and number of dies in one set may be different from those of the other set, including the case (already indicated) of where one set consists only of a single die, and in some circumstances certain of the dies in either set have a different shape or a different cross-sectional area from other dies of the same set.

In consequence of the many variations, such as indicated herein, a corresponding number of patterns of fabric may be produced.

The diameter of the annular sets of dies and the width of the rectilinear sets, need not be a determining factor in the corresponding dimensions of the extruded fabric as such may become extended considerably, for example by employing low relative displacement speeds in conjunction with closely spaced dies.

Where wet spinning plastics are to be used, the same kind of apparatus as described above is employed, except that the worm feed 2 for the plastic is replaced by a pump feed such as known in wet spinning apparatus for monofilaments to force the plastic through the die orifices which are immersed in a coagulating bath.

The basic principle and operation of the extrusion according to the invention is exemplified in Figs. 13—19 wherein are diagrammatically illustrated the several stages of the extrusion of the plastic from the dies 10 and 14 in the die-carrying members 6 and 12 (one of which is stationary).

In Fig. 13 the dies 10 and 14 are in exact register forming the composite orifices and confluent extrusion is taking place, thereby producing integral intersecting portions a of the fabric mesh. In Fig. 14 the dies are in an out-of-register position as in the separated extrusion for the mesh-forming strands b. In Fig. 15 the dies 10 and 14 are passing out of register and separating with a shearing action, dividing the mesh intersection masses at a^1 into the strands as displacement of the die sets proceeds. When the dies of each set have passed onto and are passing over the plain surface spacings between the dies of the other set, each die functions as a single independent entity and as extrusion and transverse displacement is continuing simultaneously diverging mesh strands b and b^1 are being formed (see Fig. 16) until the dies of one set come again into register (see Fig. 17) with those of the other set, when extrusions take place again through the composite die orifices of the respective sets to produce other integral intersecting portions or streams a of the mesh, this process of intersection extrusion and mesh strand extrusion being constantly repeated in the manner illustrated at Fig. 18, for example, in the production of an integral net-like fabric by the continual relative transverse displacement of dies. In Figs. 15—19 the dies 10 of the member 6 moving continuously (as in rotation) lay steep helical strands across the longitudinal strands extruded by the dies 14 of the stationary members 12.

In like manner, intersections and mesh strands are extruded by the rotation of both die-carrying members or where oscillation or reciprocation thereof takes place.

In Fig. 19 the principle of extrusion is exemplified with reference to a stationary die member 12 and the die member 6 constantly reciprocating or oscillating back and forth (as indicated by the arrow) over a stroke equal to one pitch interval of the dies.

Although the dies for many purposes are most suitable in the form of open-sided slots or grooves, as seen most clearly in Fig. 4, die ducts may be employed which in plan are closed figures as described with reference to Fig. 12.

The cross-sectional area of dies employed in this invention may be varied over a considerable range from very fine dies of the order found in the finer type of hypodermic needles for the production of correspondingly fine thread fabrics, to coarse or large cross-sectional areas for the production of stout or heavy duty mesh strands. It will be appreciated that the size of the meshes will depend upon the spacing of the dies of the sets relative to one another of each set and the rate of displacement in relation to the extrusion pressure rate and the haul off speed.

Closed figure die ducts or passageways may be formed in the die-carrying members and lined with tubes (down to the fine hypodermic needle size), the ends of the liner tubes of each set of die passages being bevelled in oppositely facing sense obliquely across a suitable portion thereof, which may be a major portion of the diameter of the tubes where the finer size of die orifices are required, the lower limit as to size being determined by the practicability of extrusion of any particular plastic therethrough. After insertion of the liners the liner tube end are bevelled in grinding the contacting surface of the slideways, such as 9 and 13, to a perfectly smooth mating finish.

It will be understood that in producing the fine strand fabrics the spacing of the dies of each will be correspondingly reduced, and in any case the mesh size may be diminished by reducing the said spacing, the minimum being not less than the diameter or transverse dimensions of the extension orifices.

With the apparatus provided with the annular sets or the rectilinear sets of dies subjected to oscillation or reciprocation, a series of separate narrow fabrics, braids or ribbons may be extruded simultaneously from

the die-carrying members instead of a full-width fabric, by arranging each set of dies in a plurality of groups each separated from one another by plain dieless portions of suitable extent and by limiting the length of the oscillatory or reciprocatory stroke to the traversal of a die group.

Although the above description has been confined to apparatus having annular rotary die sets, which is the preferred form, or rectilinear reciprocating dies, there are doubtless other forms of apparatus capable of carrying out the invention, for example there may be employed extrusion apparatus having endless steel bands disposed edge to edge, the rectilinear runs of which are appropriately spaced by terminal guide and drive rollers. At each of said edges opposite sets of dies are located. The bands may be run continuously or in reciprocation below and in closure of the aperture of an extrusion chamber.

Instead of moving both bands, one may be held stationary or a stationary die-carrying plate may be substituted for one of the bands with its die edge opposite to the die edge of the moving band.

The extrusion chamber may be located externally of and above the extrusion run of the bands, or it may be positioned within the circuit of the band when the extrusion run will be below it.

Furthermore, it will be appreciated that the apparatus illustrated for forcing and feeding plastic to the essential dies may be substituted by any known form of plastic extrusion feeding and pressure apparatus.

The fabrics as produced according to this invention may be so stout as to be more or less self-sustaining nets or they may have different degrees of flexibility and in the finer gauges of strand the fabric may be so flexible as to fall in folds or be capable of draping.

High rates of production of the extruded fabric may be accomplished as such is only limited by the possible rates of extrusion and fixation, and as the fabric is completed in a substantially single continuous process, eliminating the spinning of yarns or monofilaments and the subsequent weaving or other fabrication, manufacturing costs should be low.

Representative fabric patterns are illustrated in Figs. 20 to 25 as examples of several of the various die displacements. In Fig. 20 a fabric is shown in which longitudinal strands issue from stationary dies and steep helical strands issue from the moving dies (see also Fig. 18). In Fig. 21 a fabric is shown as produced where both sets of dies rotate in opposite directions, while when dies move in the same direction but at differential speeds a fabric as illustrated in Fig. 22 is produced. The fabric of Fig. 23 corresponds with that illustrated in formation in Fig. 19, and that shown in Fig. 24 is produced by reciprocating or oscillating both sets of dies in opposite directions with a stroke equal to one half of the pitch of the spacing interval of the dies. In Fig. 25 a similar fabric is shown to that of Fig. 24 but in this instance the stroke is equal to more than one die interval pitch.

The fabrics after extrusion and fixation may constitute the finished article or such may be subjected to further treatment or treatments according to the products it may be desired to market.

The shape or size of the meshes of the fabric as extruded, may be changed, enlarged or diminished by the application of racking tension when using drawable plastic such as nylon, polythene or the like, calculated to alter the mesh shape or elongate the mesh strands. Tensioning in one or more directions will elongate the mesh strands while having little effect upon the intersections, and thus the size or area of the meshes may be increased from that which the fabric possessed on extrusion. The shape and size of the meshes, to a lesser extent may be altered or diminished by subjecting the fabric to compression at right-angles to the plane of the fabric to flatten or spread the mesh strands and intersections.

Extruded fabrics may be laminated one upon another under pressure and heat or by cementing or other treatment, or extruded fabrics may be embedded or embodied in or laminated with sheet material, or a sheet or sheets of the same or a different plastic from that extruded.

The extruded plastic may be applied as a coating layer or armouring to one or both sides of rayon or other plastic, woollen, cotton, linen and like cloths fabricated by the known methods, by the compression thereon of the extruded fabric in the presence of heat or by the application of adhesives or cements. Other classes of article may be produced from the extruded fabric by shaping or stretching such on formers or pressing the fabric between die forms to produce containers or three-dimensional articles.

The following list will serve as examples indicating some of the uses or purposes to which the extruded fabric may be put, either in the form initially extruded or after subsequent treatment.

1. Fabrics of various patterns and textures and braid or ribbonlike material.
2. Tubular goods.
3. Netting for insect protection, fishing, agricultural, horticultural or sports purposes, etc.
4. Laminated goods.
5. The stiffening or reinforcing of other fabrics of known type.
6. Filtering or sieving.
7. Armouring upholstery or other fabrics or

driving belts, belt conveyors or cables or ropes.

8. Fabric reinforcement of rubber tyres.

9. Towing targets of net form for aircraft.

10. Furnishing fabrics such as curtains, tablecloths, counterpanes, etc.

11. Pan scrubbers.

12. Baskets, bags or other containers.

13. Basket chairwork, hammocks, screens or lattices and the like.

14. Foundation garments or girdles, surgical fabrics such as elastic stockings.

15. Millinery.

Apparatus similar to that described herein forms the subject of a divisional application No. 9011/1959 (Serial No. 836,556) for the production of plastic ribbed sheeting.

WHAT WE CLAIM IS:—

1. A plastic net or net-like fabric having mesh strands and intersections, characterised in that the intersections are each composed of an integrally extruded mass and the mesh strands are divisions from the said intersections, the whole net being an integral extruded entity.

2. A method of manufacturing a plastic net or net-like fabric, characterised by extruding the plastic through two sets of die orifices, which sets are relatively displaced transversely to the direction of extrusion into positions in which die discharge orifices of one set are in registration with those of the other set to provide a series of individual orifices each composed of an orifice of the respective sets, during which registration, extrusion of the net intersections takes place through said composite die orifices and into positions of non-registration of the die orifices of the sets through each of the orifices of which independent extrusion takes place of the mesh-forming strands which are divided from the intersections with a shearing action as the dies move from the registration to the non-registration position.

3. A method of manufacturing a plastic net or net-like fabric as claimed in Claim 2 characterised in this that the plastic emerging from the dies is subjected to cooling or other treatment to set or fix the plastic.

4. Apparatus for carrying out the method claimed in Claim 2 or 3, comprising means for feeding plastic under pressure to a pair of die-carrying members having contacting slideways, dies extending through the members with the die discharge orifices at the slideway surfaces and means for displacing the die-carrying members in the said transverse direction for placing the die discharge orifices of each member into positions of registration and non-registration with one another.

5. Apparatus as claimed in Claim 4 and having means for treating the net as extruded to set or fix the plastic.

6. Apparatus as claimed in Claim 4, characterised in that the die-carying members have circular and coaxial slideways and the displacement means are adapted to impart relative rotary motion between the members during extrusion of the net or net-like fabric in tubular form.

7. Apparatus as claimed in Claim 6, and having means for hauling the extruded net over a former cylinder having a surrounding ring member between which and the former the net is passed to the hauling means.

8. Apparatus as claimed in Claim 4, characterised in that the die-carrying members and their slideways are rectilinear or arcuate and the displacement means are adapted to impart relative reciprocating or oscillatory motion between the members.

9. Apparatus as claimed in Claim 4, 6 or 8, characterised in that the dies of the members are in the form of slots or grooves which open laterally onto the slideway surfaces.

10. Apparatus as claimed in Claim 4, 6 or 8, characterised in that the dies of the members are in tubular form having their discharge orifices intersected by the slideway surfaces such that when in register with one another they form single composite extrusion orifices for forming the integral intersections.

11. A method of treatment of the net or net-like fabric produced by the method of Claim 3, consisting in subjecting the fabric to tension, such as known for adding strength to nylon monofilaments, in one or more directions such as will elongate the mesh strands while having little or no effect upon the intersections.

12. A plastic net or net-like fabric when produced according to the method claimed in Claim 2 or 3.

13. A plastic net or net-like fabric when produced by apparatus as claimed in any of the Claims 4 to 10.

14. A plastic net or net-like fabric produced by the method claimed in Claim 11.

MARKS & CLERK.

PROVISIONAL SPECIFICATION

Improvements relating to the Production of Net or Netlike Fabrics by Extrusion Methods

We, PLASTIC TEXTILE ACCESSORIES LIMITED, a British Company, of 8, St. Peter Street, Blackburn, Lancashire, do hereby declare this invention to be described in the following statement:—

This invention has for its object to make

possible the production of net or netlike fabrics from extrudable plastics such as plastic melts in a single basic operation, in contradistinction to previously proposed production methods involving extruding monofilaments which are laid in crossing or contiguous relation upon a travelling band or drum so that they may become welded or stuck together at the crossing points or overlapping of the filaments.

The invention provides for the production of fabrics at high speeds, and for the production of fabrics which will drape satisfactorily, contrary to the accepted belief that if fabrics were not either woven or knitted they would not drape.

According to the invention, fabrics are made by extruding melts of fibre-forming materials (hereinafter called plastic) through apertures which are constantly in motion with respect to other apertures and are intermittently united with such other apertures, so as to produce extruded filaments intersecting one another at intervals.

The apertures may be formed by fine grooves or channels in abutting edges of metal plates, which plates may be reciprocated in opposite directions. Or at least one plate may have an endless edge which travels constantly over the edge of the other plate.

The invention is illustrated by way of example in the accompanying diagrammatic drawings.

As shown in Figure A1 two plates 1, 2, are placed edge to edge; along the edges of these plates slots 3 have been cut, of small dimensions and usually spaced at regular intervals. Figure A2 shows some of the shapes to which the slots may be cut. Through these slots the plastic is forced while at the same time the plates are moving from side to side in opposite directions. As the plastic emerges from the forming plates it is set either by rapid cooling or by coagulating bath according to the type of plastic used. If the plates were stationary, filaments would be formed, but as the plates are moving a bond is formed each time a slot in the plate 1 coincides with a slot in the plate 2, thus forming a continuous mesh. The relative movement of the plates 1, 2, is at least such that a slot of one plate coincides alternately with two adjacent slots of the other plate.

Figure A3 and B3 show a few of the fabric structures which can be obtained by this method.

Figure B1 shows a stationary plate 4 with an endless flexible band 5 at the top. Slots 6 are cut along one edge of the plate and completely round one edge of the band. The band 5 is caused to travel over rollers, with a flat stretch which is guided to slide in close contact with the plate 4. The speed of the band determines the angle of the twill patterns. Different sizes of slots can be cut in the blade to give ribbed twill effects. The plastic is forced through the slots only over the length of the stationary plate 4.

Figure B2 shows two endless flexible bands 7, 8, located edge to edge but travelling in opposite directions. This method forms a diamond pattern suitable for netting. If thermoplastic melts are used the fabric can be mechanically twisted so that the diamonds become squares and the fabric is then heat set in its new shape.

Figure C1 shows an arrangement for making circular or tube fabric suitable for tubular goods. The slots are cut into the outside and inside edge respectively of two circular plates 9, 10. The plates usually revolve in opposite directions but for certain constructions one plate can be stationary. The plastic is forced through the slots as in the previous methods. The fabric is drawn off at a controlled speed to ensure even spacing of the mesh.

In certain cases it has been found necessary to blow cool air on the fabric after it is formed to avoid deformation before complete setting.

The following list gives only a few of the many uses for the products of this new manufacturing method.

Underwear; dress fabrics; blouse fabrics; shirting; net (wearing); fishing nets; curtains; upholstery.

MARKS & CLERK.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1960.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained

836,555 PROVISIONAL SPECIFICATION

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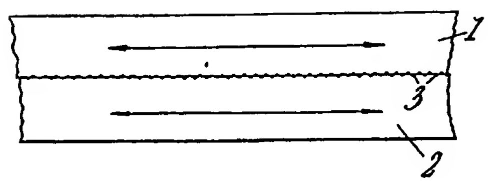

Fig.A1.

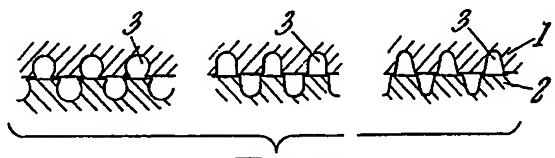

Fig.A2.

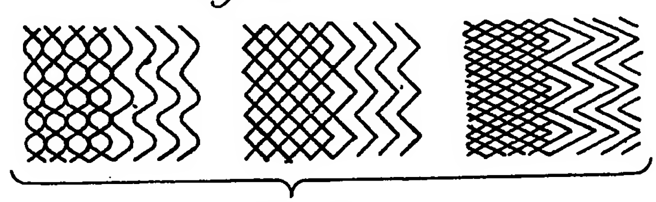

Fig.A3.

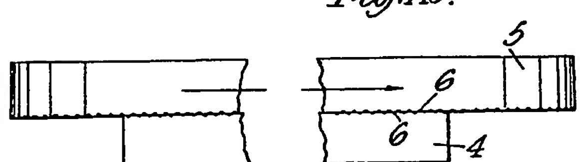

Fig.B1.

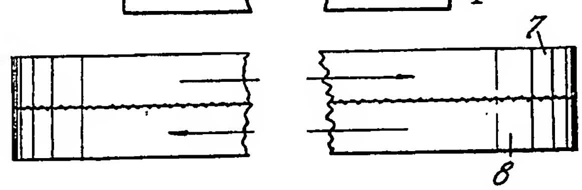

Fig.B2.

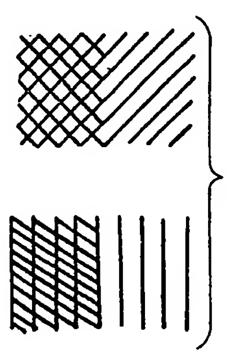

Fig.B3.

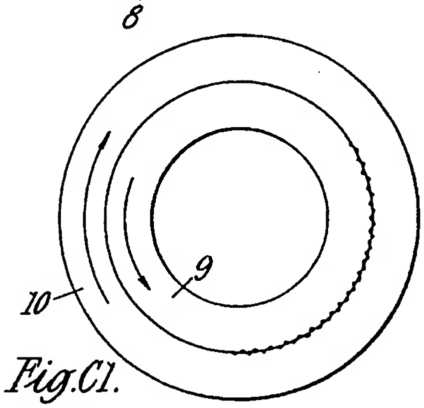

Fig.C1.

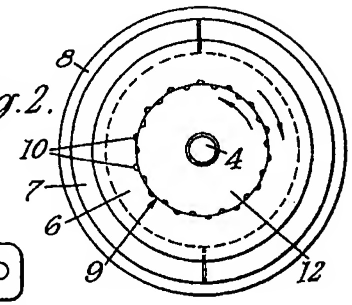

Fig.2.

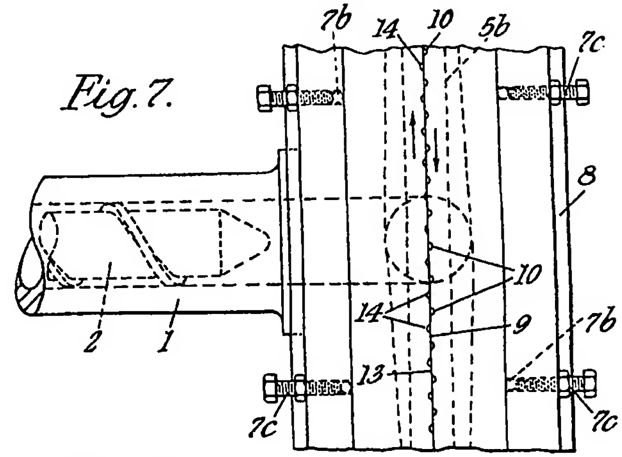

Fig.7.

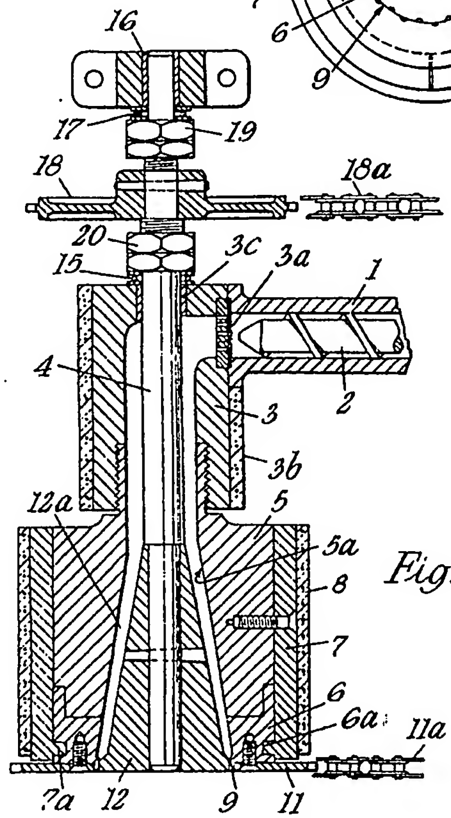

Fig.1.

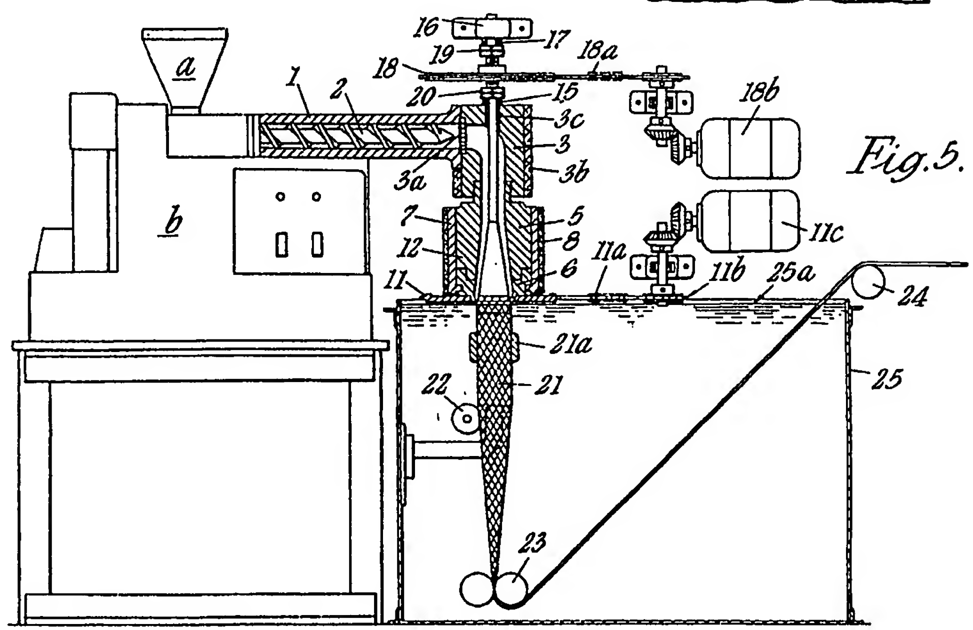

Fig.5.

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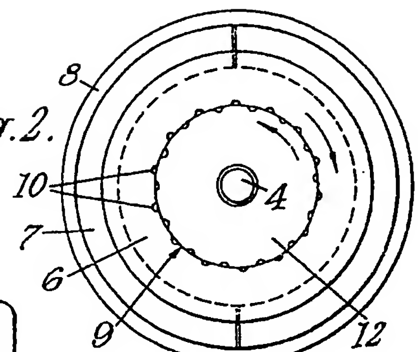
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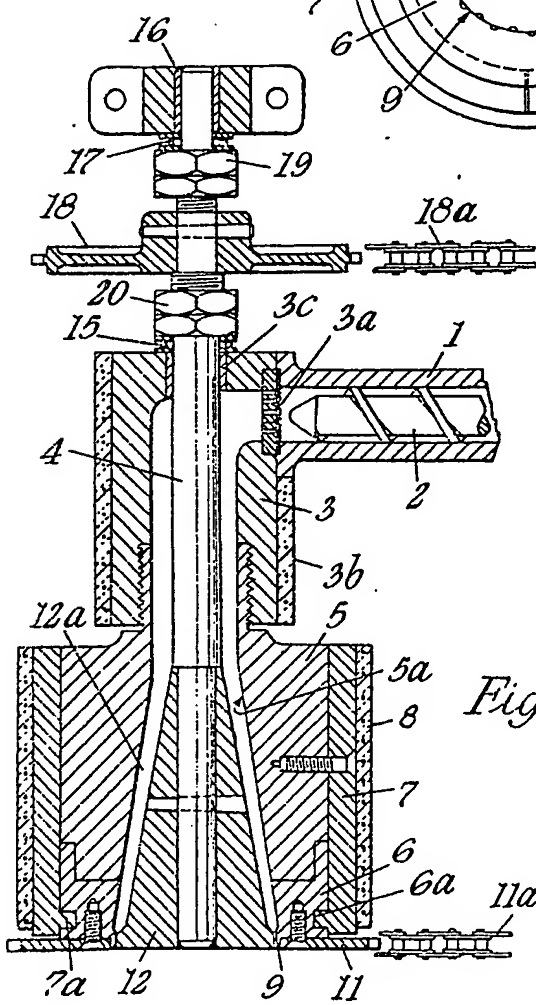
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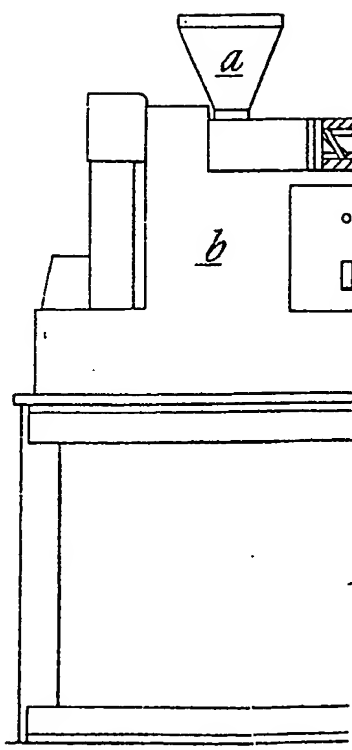
Fig. 1.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836,555 COMPLETE SPECIFICATION
6 SHEETS

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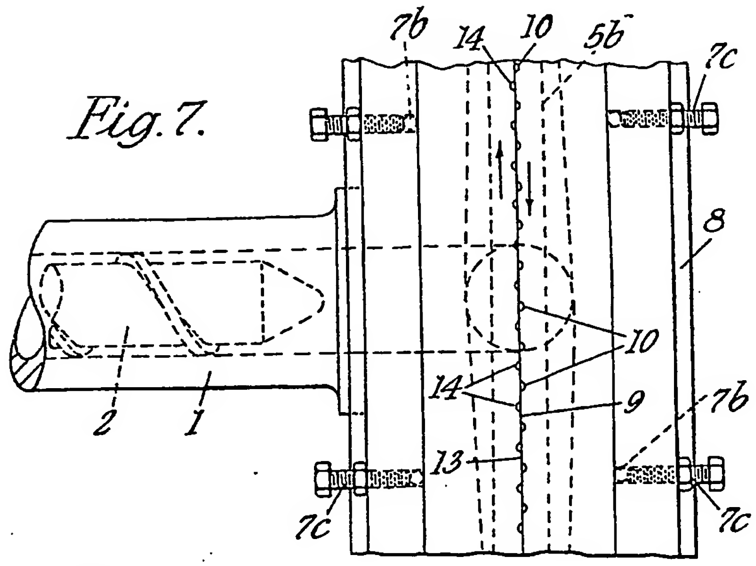
SHEET 1

Fig. 7.



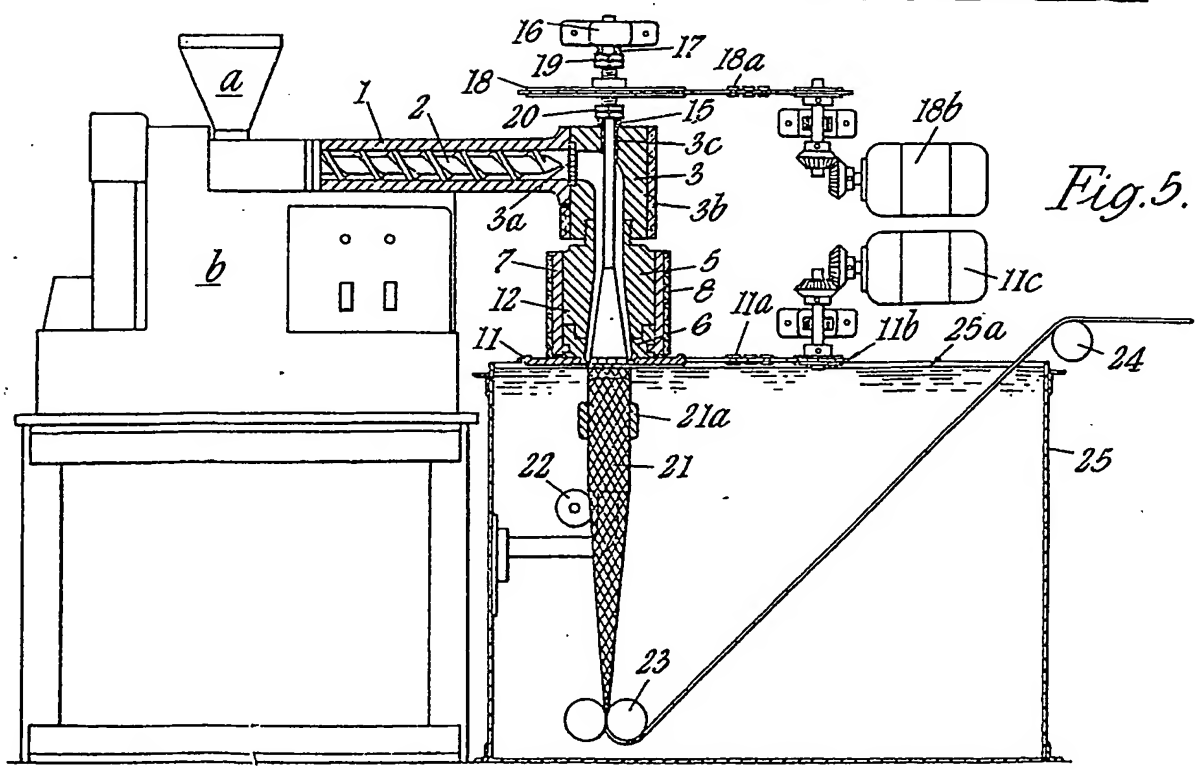
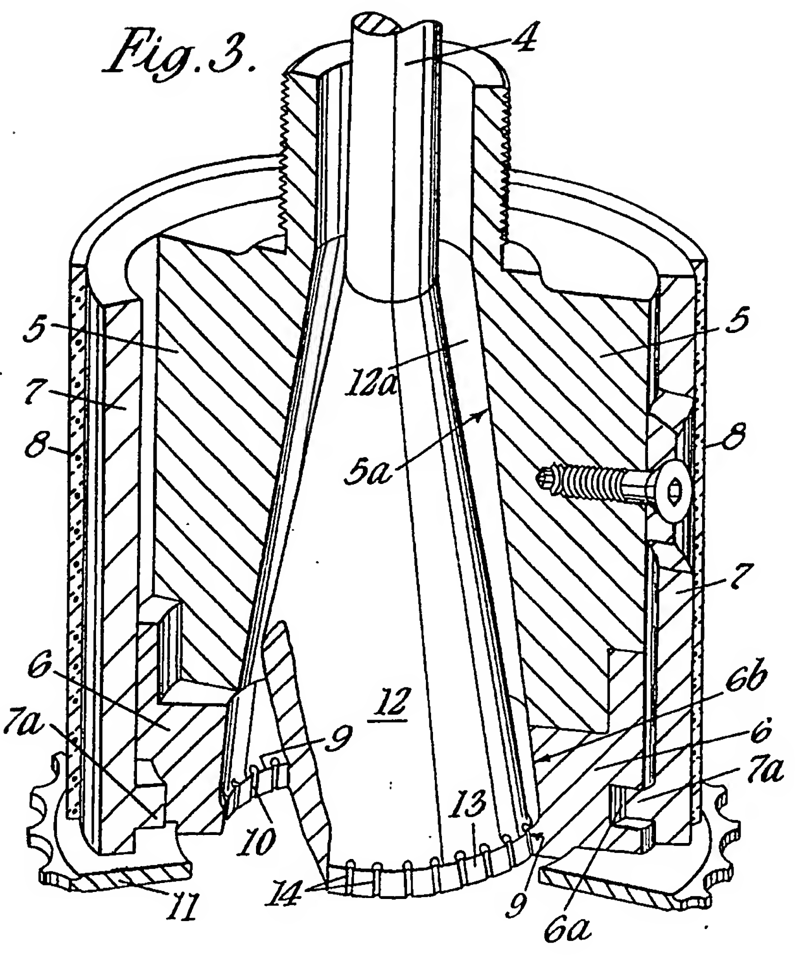


Fig. 5.

Fig. 3.



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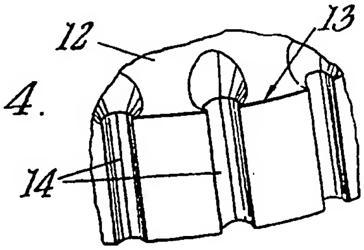

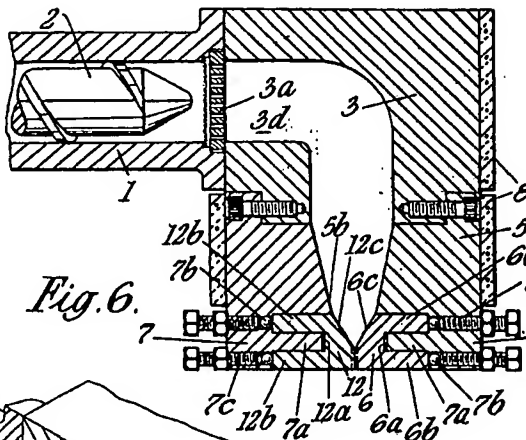

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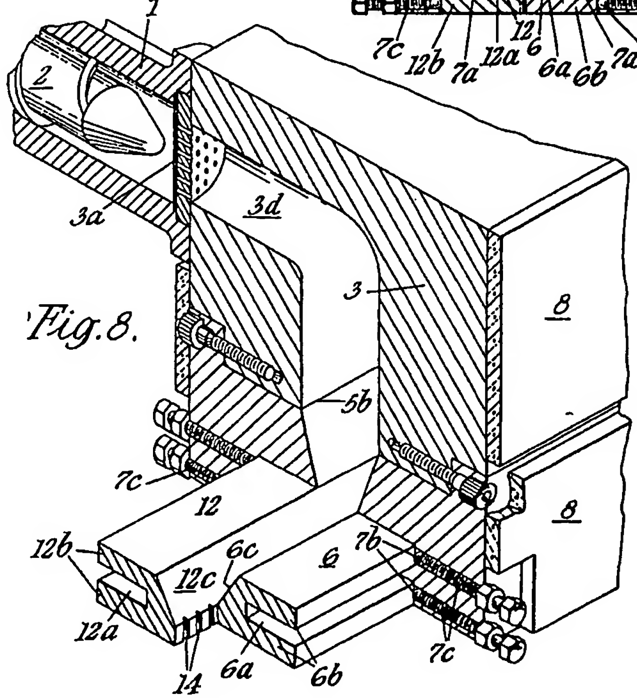

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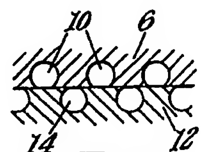


Fig. 9

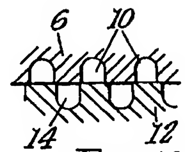
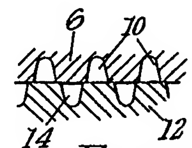


Fig 10



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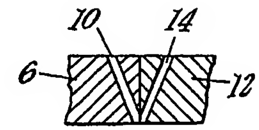

Fig. 12.

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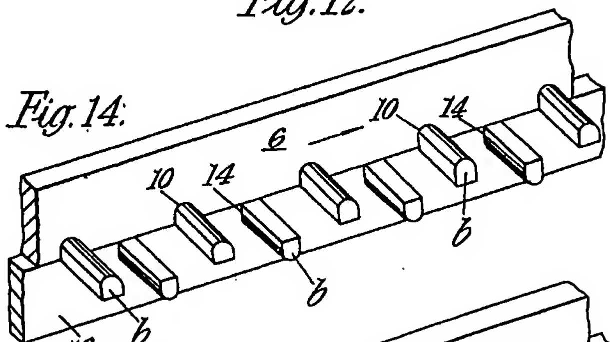

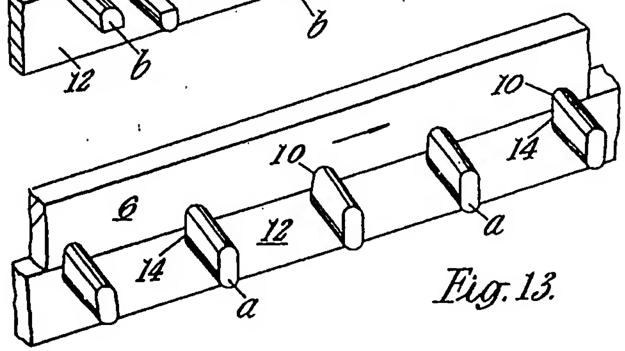

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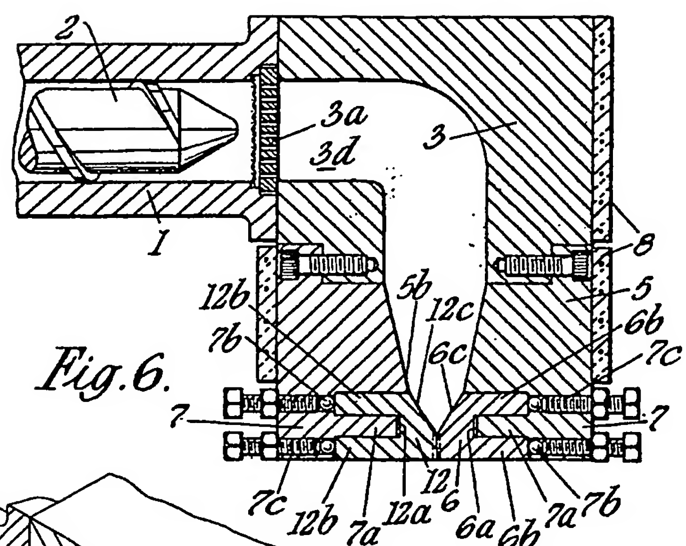

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Fig. 6.

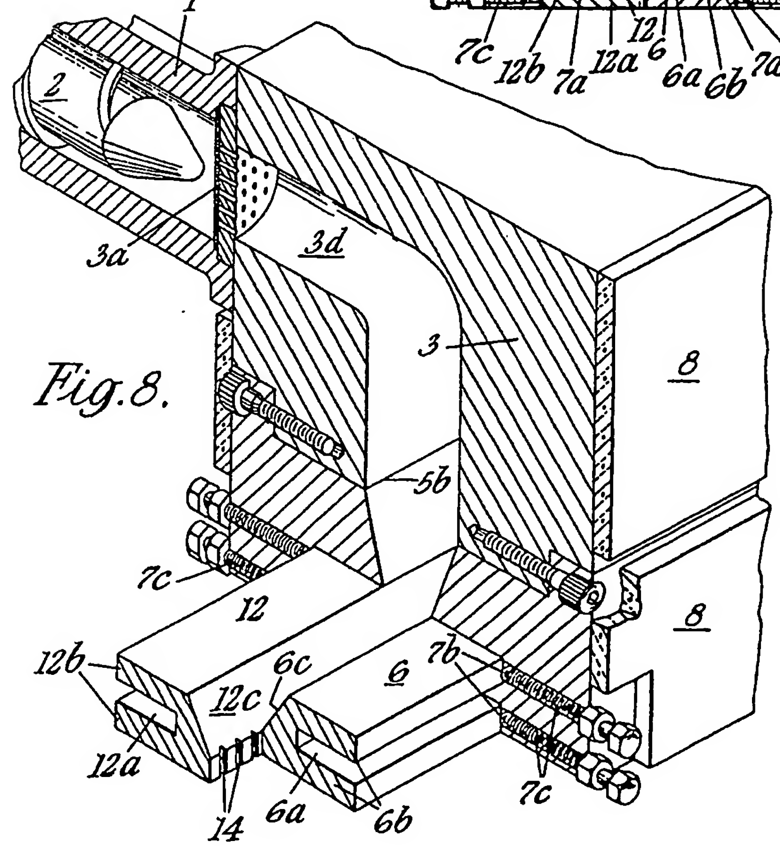

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Fig. 8.

836,555 COMPLETE SPECIFICATION
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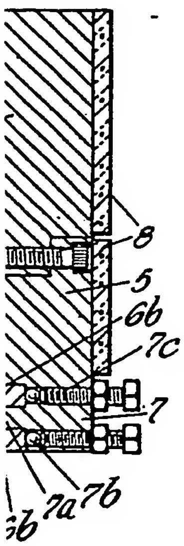
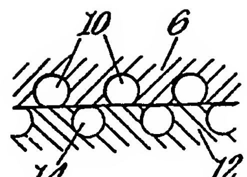
SHEETS 3 & 4





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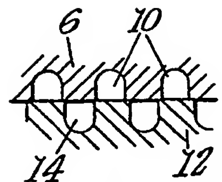

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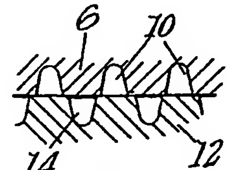

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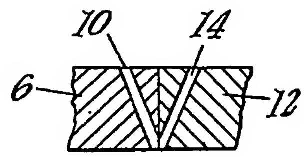

Fig. 12.

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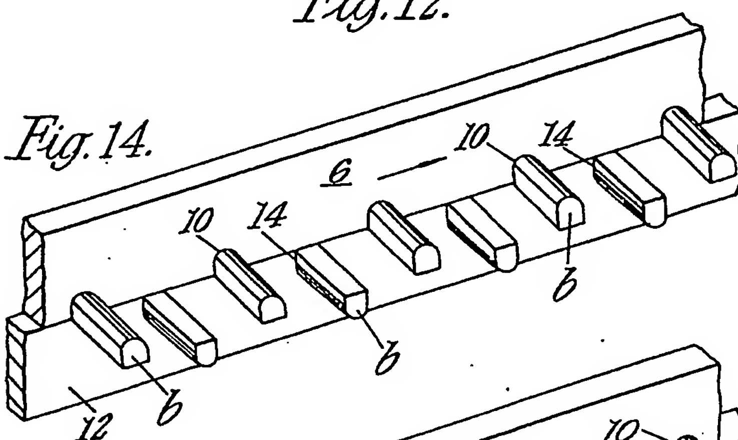

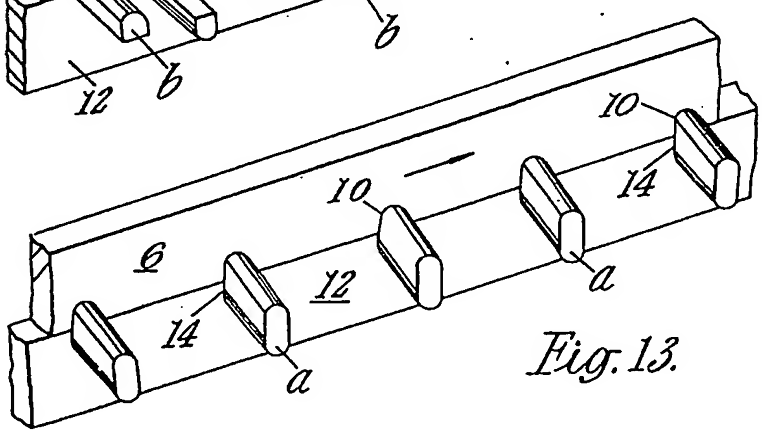

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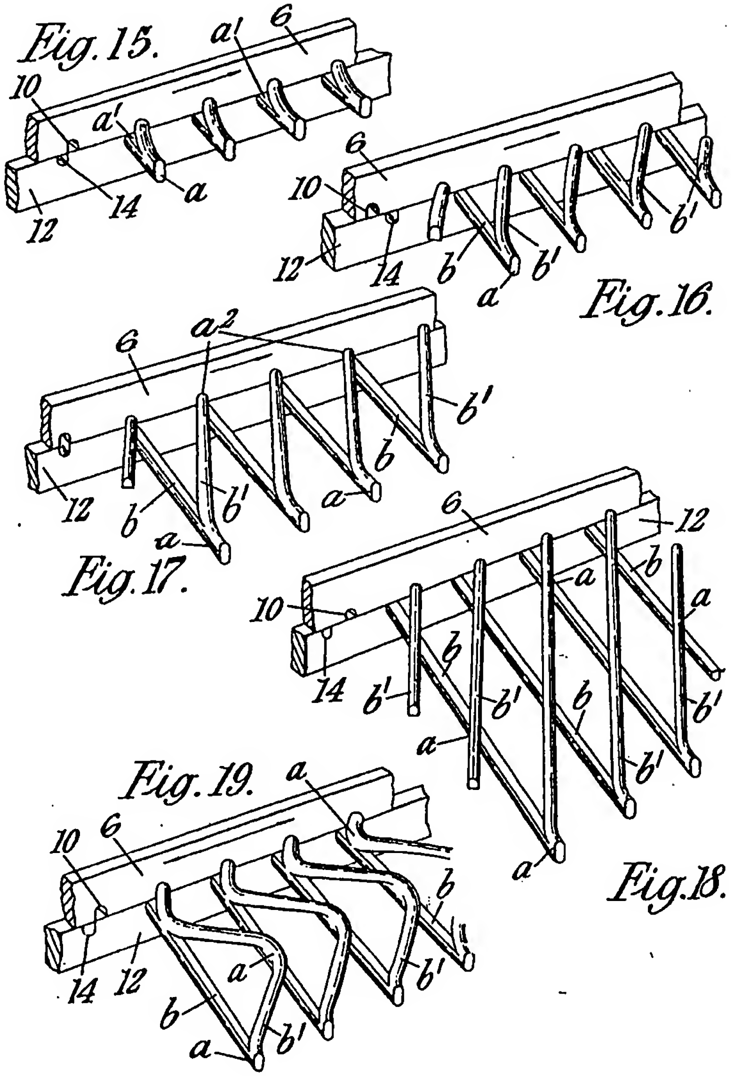
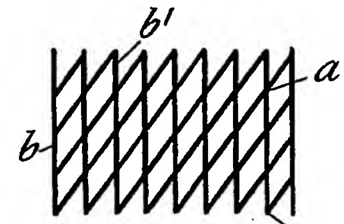


Fig. 15. Fig. 16. Fig. 17. Fig. 18. Fig. 19.



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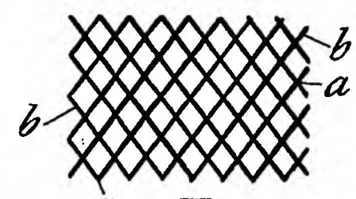

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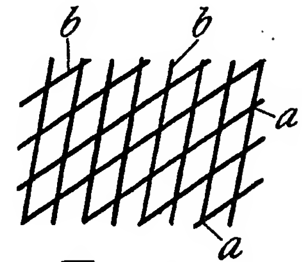

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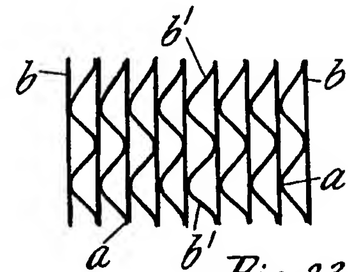

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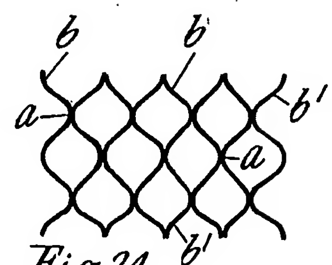

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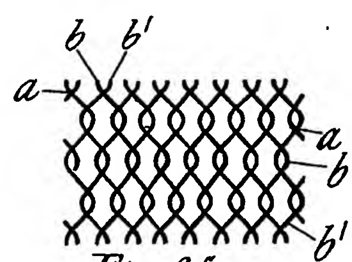

Fig. 25.

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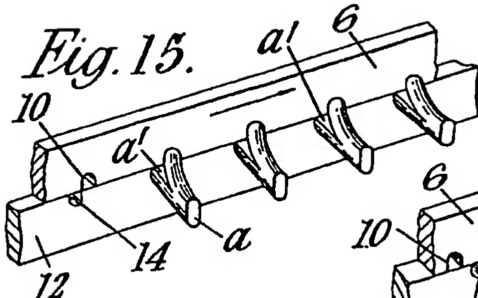

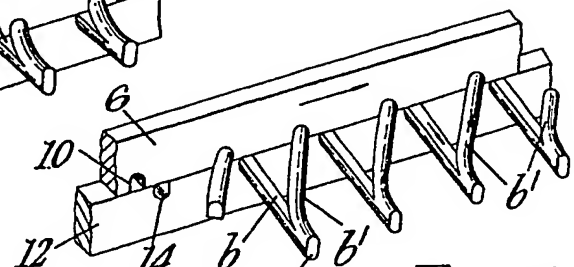

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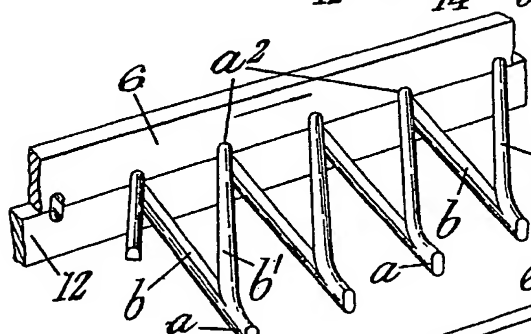

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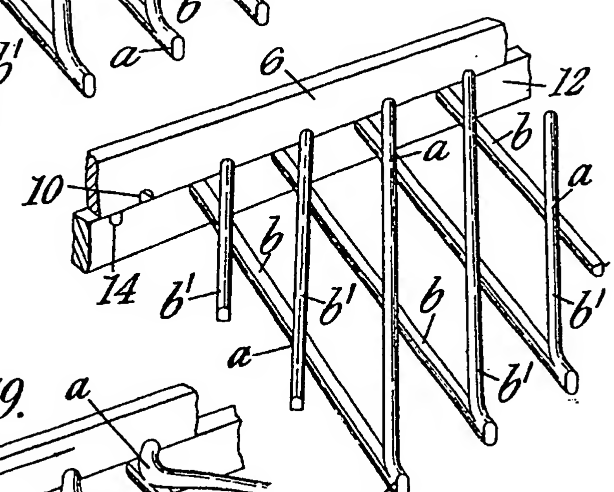
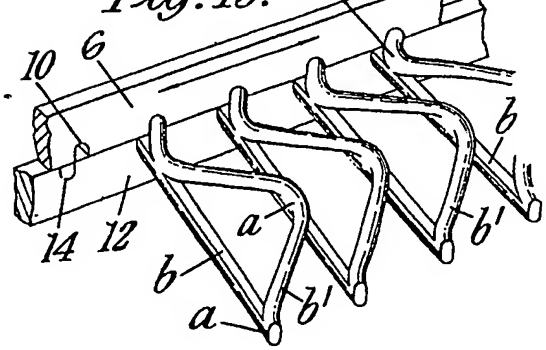
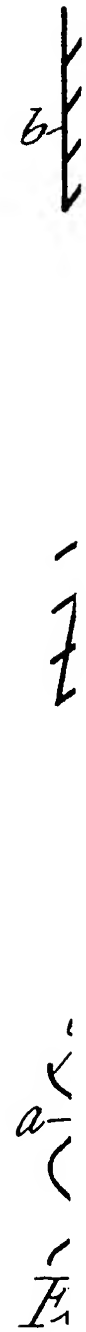


Fig. 18.

Fig. 19.





836,555 COMPLETE SPECIFICATION
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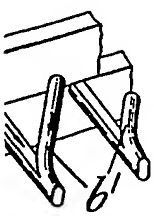
SHEETS 5 & 6



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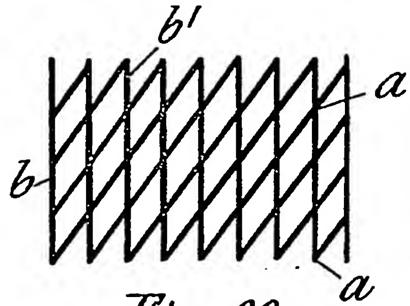

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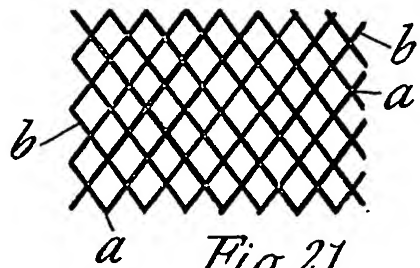

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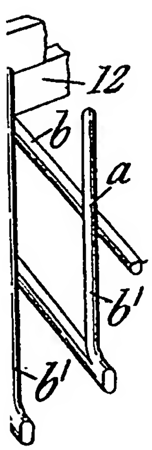

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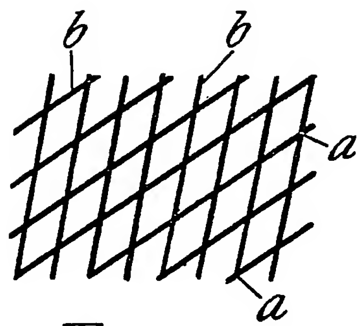

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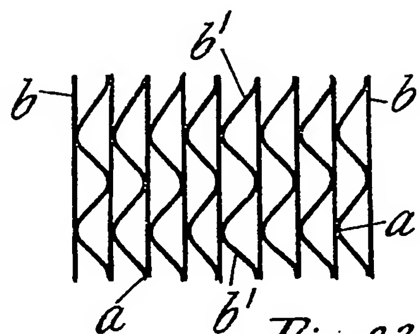

Fig. 23.

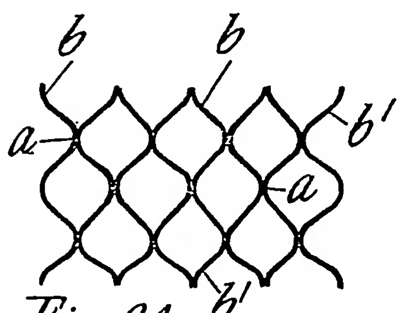

Fig. 24.

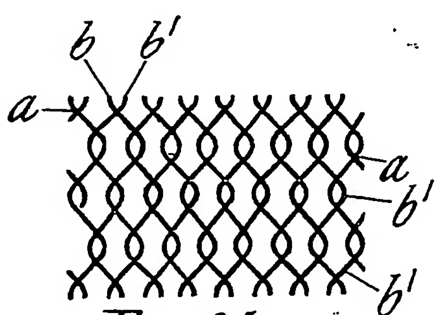

Fig. 25.